DOCUMENT RESUME

ED 170 120 SE 027 523

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TITLE The Use of the Performance-Oriented Instructional Worksheet in Meeting Instructional Needs Within the Environmental Protection Agency.
INSTITUTION Environmental Protection Agency, Washington, D.C. Office of Water Programs.
PUB DATE Oct 78
NOTE 26p.; Contains occasional light and broken type

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Administrator Guides; *Behavioral Objectives; Evaluation; *Instruction; *Instructional Improvement; Job Skills; *Performance Criteria; *Postsecondary Education

ABSTRACT

This booklet provides a step-by-step guide to non-traditional educators for developing and writing behavioral objectives. Worksheets and guidelines are provided to assist the instructor in developing individual lessons and course materials. A model is provided for reference. (CS)

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United States
Environmental Protection
Agency

Office of Water
Washington DC 20460

October 1978

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Use of the Performance-Oriented Instructional Worksheet

Meeting Instructional Needs Within the Environmental Protection Agency

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The Use of the Performance-Oriented Instructional Worksheet in Meeting Instructional Needs Within the Environmental Protection Agency

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OCTOBER, 1978

TABLE OF CONTENTS

	Page
INTRODUCTION	1
INSTRUCTOR/PRESENTER - A DECISION MAKER	1
USE OF THE PERFORMANCE-ORIENTED INSTRUCTIONAL WORKSHEET	2
PERFORMANCE OBJECTIVES	3
HIERARCHY OF PERFORMANCE OBJECTIVES	7
JUSTIFICATION	10
PREREQUISITES	10
BLANK WORKSHEET AND GUIDELINES FOR USE	11
MODEL	17

Introduction

The Performance-Oriented Instructional Worksheet (POIW) has been prepared in a specific format which permits the user maximum flexibility in applying it to a learning situation. The intent of this approach is to clearly identify those learning outcomes which are job related and specifically measure the result of the learning experience in behavioral terms. This approach has been referred to as the "systems approach to learning" and it is being used extensively in many levels of education and in many specific training programs both within and outside formal educational institutions. This approach has been valuable in many different levels of application; it has proved to be successful both as an instructional method and as a means of managing an instructional program. The POIW has been developed to provide a management tool necessary for successfully implementing a learning situation.

Even though the material appears to be highly structured and rigid, it is in fact a flexible tool which provides an instructional format to adjust, adapt, delete and/or add to your particular education/training needs. Do not let the format serve as a block to the wide degree of flexibility which is inherent in this approach. The systemized format is necessary to insure that all learning objectives have been addressed. It allows for an accounting of common prerequisites, different modes of presentation for different types of material, identification of learning material, etc.

The Instructor/Presenter - A Decision Maker

Every day instructors/presenters make many decisions regarding what to say, why to say it, how to say it, and how to determine when learning has taken place. These decisions should follow a carefully designed methodology which includes a task analysis, a justification of the task, a statement of the performance objective, and an evaluation procedure. Whether this is a lengthy formal process or an intuitive process developed through years of experience, it is a necessary step. A task analysis is a list of those activities performed on a job with a resultant product or service. The justification of the task is a statement of the value and relationship of performing a specific task to the total agency goal or organization function. Quite often these justifications, which concentrate on these small necessary incremental steps; become useful tools in motivating learners and framing the big picture. Objectives are goals for desired outcomes of learning and are expressed in terms of observable behavior or performance of the learner. Evaluation represents the validation step in the transfer of information from the instructor/presenter to the learner.

Knowledge involves the recall of specifics and universals such as: the recall of methods and processess, or the recall of a pattern, structure, or settings. For evaluation purposes, the recall situation involves little more than bringing to mind some associated material. In many

cases an alteration of the material may be required. This is generally a minor part of the task. The knowledge objectives emphasize most is the psychological processes of remembering. The process of relating is also involved in learning in that a knowledge test situation requires the organization and reorganization of a problem so that it will furnish the appropriate signals and uses for information the learner possesses.

Use of the Performance-Oriented Instructional Worksheet

The POIW serves as a guide for the instructor/presenter as the particular training program is implemented. This instructional guide can be used in many ways for varying training situations. For example, POIW's could be used as lesson guides for a seminar or short course which involved several instructors/presenters. A careful analysis of learning needs and an accurate definition of instructional accountability will eliminate much wasted time and effort of many instructors/presenters. If the instructional objectives have been defined prior to the learning situation, the worksheets can be forwarded to the instructors/presenters for their review of the technical content and determination of the relationship between their assignments and the assignments of other instructors. The worksheet is always open to review and revision as long as the overall goal of the learning situation is being met. It is better to send the instructor/presenter a list of learning outcomes for which s/he will be held responsible than to send a list of topics s/he should cover. This does not cast learning outcomes in concrete but rather establishes specific outcomes which can then be questioned, justified, and/or adjusted, based upon new information, instructor/presenter background, agency goals, learner background, etc.

The POIW can serve as a blueprint for a specific portion of a learning situation. This same worksheet can be used in a selfpaced mode. Since the worksheet is self-explanatory a learner can engage in the identified learner activity using those stated instructional resources and take the post test for that module. If the level of performance is not met, the learner recycles through those activities until the stated performance level is achieved. The POIW's, with the necessary reference materials, then becomes a total learning package to be completed at the pace of the individual learner.

Through the use of media, certain recurring but constant learning needs can best be achieved. The POIW identifies the media and/or provides suggested media for development. This identification states how and when the learning media is to be used in meeting the learning objective. Quite often education managers and instructors allow the learning media to dictate the performance objective. Obviously in most learning situations there exists neither the time nor the resources to develop specific media. Consequently, instructors/presenters must often rely on existing media. The POIW can assist in identifying within existing media specific information which is pertinent to the learning being addressed and de-emphasize peripheral information in media. The major item on the POIW

is the performance objective. Performance objectives are discussed in more detail in the following paragraphs.

Performance Objectives

One broad classification of objectives proposed by educational psychologists involved with human behavior includes the psychomoter, cognitive, and affective domains. The principal reasons for classifying objectives are (1) to assure that the total amount of must-know or job-necessary information is conveyed rather than concentrating on peripheral information, (2) to assure prerequisite skills are identified prior to their use in the more complex skills and (3) to assure that appropriate instruments are employed to evaluate the desired objectives.

The psychometer domain is that domain associated primarily with the manipulation, coordination, and dexterity of muscle systems. The cognitive domain deals with the knowledge of facts and information in the general sense. The affective domain addresses that portion of knowledge dealing with values and biases. Quite often more than one behavioral domain is required in an objective. This has been suggested as a possible drawback for classifying behavioral domains. The important thing is that the classification process is entered into and a genuine effort is made to recognize the relationships between them. In practice it is virtually impossible to isolate the three behavioral domains.

The justification from the learners point-of-view of using behavioral objectives is found in their accountability of the instruction process. Quite often an instructor/presenter evaluates a learner on the association of a value to a specific bit of information, when in fact his/her success on the job depends only on the knowledge of that bit of information. If the learner is to be held accountable for developing an awareness of values similar to the instructor/presenter and it is job related, s/he should be alerted.

An objective, in an instructional context, is a stated outcome of the proposed change of the learner. The outcome of the objective must be a demonstrable change in the learner's behavior pattern. The behavior pattern change must be in measurable attributes with stated performance standards. Quite often these objectives are referred to as behavioral objectives in reference to this behavioral pattern change. When clearly defined objectives are missing, it is difficult to evaluate the effectiveness of the learning situation. Since the learning situation consists of subject matter based upon task analysis, instructional material and instructional techniques, the between parts and whole parts are difficult to evaluate.

Performance objectives relate most directly to evaluation and testing. These validation steps which ascertain effectiveness of instruction must be stated in measurable terms that reflect the learners ability to perform the necessary skills and/or state the necessary facts.

Another important use of performance objectives is by the learner ascertaining his or her own progress in the instructional sequence. With clearly stated objectives, the learner has no need to question the relevance or irrelevance of bits of instructional information. The learners ability to monitor success in following the instructional material and meeting the prescribed outcomes established by the instructor is an extremely important aspect of this approach to instruction.

Performance objectives represent a system approach to the learning process. It is an informational flow system from instructor/presenter to learner with several points of validation, positive means of feed-backs, and identified sources and links of information.

In using performance objectives the following questions concerning the subject matter and the learner must be asked by the instructor/ presenter:

1. Who will exhibit the behavior?

2. What observable performance is the learner expected to exhibit?

3. What conditions, objects, or informational sources are given?

4. Who or what sets the terms of the learners performance?

5. What responses are acceptable? Are there any special restrictions on these responses?

Performance objectives operate at various levels, originating from the specific task analysis evolving through unit or lesson objectives, to global objective, which could be a seminar, course or curriculum objective.

The performance objective leaves no room for peripheral arranged facts which are not directly related to the intent of the instruction. The ability to cut through this information in a systematic manner can in many cases make order out of chaotic subject matter and make available uncommitted time for new or more pertinent instructional intent. Many training efforts have diffused into meaningless arrays of facts quite often referred to as survey efforts. The use of performance objectives suggests a system for concentrating the essence of the information into time and resource constraints.

The lesson performance objective is directed toward the learner in an effort to best communicate the intent of the instructor/presenter. This communication should be explicit enough to minimize the doubt the learner might have concerning what s/he must do to reach that objective.

This explicitly stated performance objective has three characteristics:

1. The Terminal Behavior - the form of measurable behavior that the instructor/presenter will accept as proof of successful completion of the subject matter.

2. The Conditions - those constraints under which the terminal behavior will be measured. These include such things as types of reference material present, the physical environment, the ancillary supplies or equipment, and the nature of the learner's presentation.

3. Accepted Performance - the level of performance the learner must achieve to denote successful completion of the subject material.

A performance objective is a statement which clearly shows a proposed change in the learner's behavior which can be demonstrated. The behavior change must be measurable, matching stated performance standards. Quite often these performance objectives are referred to as behavioral objectives in reference to this change, or as instructional objectives to emphasize their educational uses. When clearly defined performance objectives are missing, it is difficult to evaluate the effectiveness of a teaching or training program. Since the teaching or training program consists of subject matter based upon task analysis, the value and effect of the instructional material can be evaluated more readily. This demonstration of accomplishment is most important today when we are being held more and more accountable for the effectiveness of our education/training efforts.

The verb describing the new behavior is the critical part of the performance objective. A wise selection will allow you to choose an acceptable measuring device (test item) for the behavior. The verbs listed in the first column are verbs open to many interpretations and for that reason are not used in writing performance objectives. Those verbs listed in the second column are much more explicit in defining what the learner will do to demonstrate the desired outcome.

1. Verbs open to many interpretations:

   a. To know

   b. To understand

   c. To really understand

   d. To appreciate

   e. To fully appreciate

   f. To grasp the significance of

   g. To enjoy

   h. To believe

   i. To have faith in

2. Verbs open to fewer interpretations:

   a. To write

   b. To recite

   c. To identify

   d. To differentiate

   e. To solve

   f. To construct

   g. To list

   h. To compare

   i. To contrast

Hierarchy of Performance Objectives

Performance objectives operate at various levels, originating from the specific task analysis envolving through unit or lesson objectives, to global objective, which could be a seminar, course, or curriculum objective. These can be arranged in a hierarchy, as follows:

C U L M I N A T I N G A C T I V I T Y
Level (Job, curriculum, program)

G L O B A L O B J E C T I V E S
Section (Course, seminar, etc.)

U N I T O B J E C T I V E S
Subject matter

M O D U L E S
Single concepts

L E S S O N
One class or study period

I N C R E M E N T A L O B J E C T I V E S
Individual learning steps

The culminating activity may be a degree being sought, or a job with many skills, such as a Wastewater Treatment Plant Operator. Several seminars, courses or global objectives will be required to earn this goal. Quite often one particular instructional program is a small part of the total learning effort required to do a particular job.

Global, section, seminar or course objectives communicate to the learner the desired prerequisite skills needed before entering the learning situation and what s/he will be able to achieve after successful completion of the learning. The global objectives do not specify what the learner must do to meet the objectives. Global objectives describe the nature of the product, not the process involved in obtaining the product. Each global objective may consist of five to thirty unit objectives. Global objectives are used most effectively in the management of learning programs rather than in the direct implementation of the learning program.

A unit objective is the first step toward separating common segments of learning, showing how to successfully achieve each global objective in some sequential form. In some cases, there is only one possible sequence of unit objectives depending on the prerequisite skills. However, in most cases some of the units might be parallel to other units in the information flow. Then the instructor/presenter chooses how to sequence these units before such knowledge or skills become required. Each unit objective may consist of one or more modules and three to twenty incremental objectives.

A module is a group of incremental objectives which makes a coherent, single-concept learning package. The module will usually be made up of two to ten incremental objectives and one-half to three lessons/presentations of one hour each. The incremental objectives should be sequenced to give maximum efficiency for the learner.

A lesson/presentation is an arbitrary unit of learning or lecture time which may cover one or more incremental objectives and one or a fraction of a module. Again, sequencing of incremental objectives is of primary importance for effective use of time.

The lesson/presentation objective is directed toward the learner in an effort to best communicate what the instructor/presenter wants from the learner. This communication should be clear enough to minimize any doubt the learner might have concerning what s/he must do to reach that objective.

This clearly stated lesson/presentation objective has the three characteristics stated earlier: the terminal behavior, the conditions, and the performance level required. Each incremental objective may have several smaller learning steps involved to help master the objective. For example, the hierarchy of performance objectives would look like the following:

Sample Hierarchy of Performance Objectives for Instructional Development:

a. Culminating Activity - Curriculum Level

You will be able to prepare a curriculum consisting of four or more courses. These will show the prerequisite skills required to enter the curriculum, a broad terminal performance to show what is expected, instructional sequencing, instructional capabilities required, instructional resources (supplies, materials, equipment, facilities, funds), potential employment opportunities, and provisions which graduates must meet for certification, licensing, civil service, union and/or other types of regulatory systems.

b. Global Objective - Course Level

You will be able to prepare a course description composed of the purpose of the course, prerequisite skills required, terminal performance objectives, instructor and student activities, and available or suggested instructional resources.

c. Unit Objective - Subject Matter Level

You will be able to prepare a set of objectives for a given subject area which will lead a trainee through a series of steps to demonstrate some new knowledge or perform a new skill. Each objective will contain a performance verb, conditions and performance level.

d. Module - Single Concept

You will be able to select and sequence incremental objectives to make a single-concept package. The selected incremental objectives should make a coherent package which can be taught in three or fewer lessons.

e. Lesson - Class Period

You will be able to state the time required to teach a given module and select from the module that sequence of incremental objectives which can be learned in one lesson.

The first set represents the hierarchy of objectives for an instructor preparing new material for instruction. You will note how each level develops the description of what must be done in more and more detail. This is particularly evident when you compare the incremental objectives for the instructor and learner. However, it should be very clear to you or another instructor just what the instructor who wrote this incremental objective wants to be included in the performance of these learners.

Justification

Preparing performance objectives requires a commitment of time and human resources to a more effective learning experience. Considerable instructor/presenter time must be dedicated to task analysis, incremental objective preparation, unit objective preparation, and global objective preparation. This requires an in-depth analysis of the subject matter. In many areas, especially scientific and technical areas, the rapid change in technology, newly discovered information, revised environmental standards, etc., continually enlarge the information base from which performance objectives are derived.

Once an educational/training information system is established, the learning materials can be quickly revised, because a framework exists for reordering, sequencing, or deletion of subject matter, if the content must be changed.

Since both instructor and learner must exert considerable effort to master performance objectives, we must justify them as clearly as possible. This justification may or may not be given to the learner, but should be kept in mind while developing the learning material. If performance objectives cannot be justified, they should be deleted. To justify performance objectives, simply answer the question: Why must the learner be able to accomplish this performance objective?

Prerequisites

The prerequisite skills are those which are necessary to perform the objective under study, but which are not a part of this performance objective itself.

The prerequisite requirement assures the instructor that s/he has adequately analyzed the performance objective from the learner's point of view. The performance objective should be placed in relationship to those assumed skills and concepts.

BLANK WORKSHEET AND GUIDELINES
FOR USE
(POIW)

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PERFORMANCE-ORIENTED INSTRUCTIONAL WORKSHEET

The following format is a management tool for developing educational/training materials to be used as: Curricula Staff Guides, Training Course Curriculum Guides, Instructional or Training Presentation Guides. The worksheet will provide an instructor or education/training manager exactly what the developers believe are the must items that need to be taught in a given training program. The major purpose of this worksheet is to secure a greater degree of uniformity and of excellence in water/wastewater technology training programs. The twelve headings given below are to be used, in sequence shown, for each segment of learning that is being developed. Headings I to IV and VIII offer a choice of terminology to the developer. For additional instructions on how to use the worksheet, see guidelines for using the "Performance-Oriented Instructional Worksheet" (attached).

I. (CURRICULUM) (LEVEL) TITLE:

II. (COURSE) (SECTION) TITLE:

III. (SUBJECT MATTER) (UNIT) TITLE:

IV. (UNIT OF INSTRUCTION) (MODULE) TITLE:

V. LESSON TITLE:

VI. ESTIMATED TIME FOR THIS LESSON:

VII. PREREQUISITES FOR THIS LESSON:

VIII. (INSTRUCTIONAL OBJECTIVE) (PERFORMANCE OBJECTIVE) (3 PARTS):

A. ACTION/TERMINAL BEHAVIOR:

B. CONDITIONS:

C. ACCEPTABLE PERFORMANCE:

IX. JUSTIFICATION OF OBJECTIVE:

X. INSTRUCTIONAL RESOURCES:

A. SELECTED:

B. SUGGESTED FOR DEVELOPMENT:

XI. INSTRUCTIONAL ACTIVITIES

A. INSTRUCTOR ACTIVITY:

B. LEARNER ACTIVITY:

XII. METHOD OF EVALUATION;

date when written

GUIDELINES FOR USING THE PERFORMANCE-ORIENTED INSTRUCTIONAL WORKSHEET

Put the following information beside each of the headings given on the worksheet. (For a sample worksheet, see attached MODEL SHEET).

I. (CURRICULUM) (LEVEL) TITLE: Place here the title of the entire course of study for which materials are being written.

e.g. CURRICULUM: FOUR YEAR WASTEWATER TECHNOLOGY PROGRAM

II. (COURSE) (SECTION) TITLE: Place here the title of the course being written as it would appear in a school or college catalog.

e.g. COURSE: CHEMISTRY I
e.g. COURSE: DESIGN II

III. (SUBJECT MATTER) (UNIT) TITLE: Write beside this heading the subject matter title for the course named under II (see above).

e.g. SUBJECT MATTER: SANITARY CHEMISTRY (for Course: Chemistry I)
e.g. SUBJECT MATTER: PLANT DESIGN FOR ADVANCED TREATMENT SYSTEMS (for Course: Design II)

IV. (UNIT OF INSTRUCTION) (MODULE) TITLE: Each course (see II above) can be divided into segments, each of which covers a broad subject area of the course. Each segment is called a UNIT OF INSTRUCTION or MODULE. Place beside this heading the title of this unit of instruction/module, followed by a number indicating its position in the course sequence.

e.g. UNIT OF INSTRUCTION 6: USE OF LABORATORY EQUIPMENT
e.g. UNIT OF INSTRUCTION 1: FLOW DIAGRAMS OF TREATMENT SCHEMES

V. LESSON TITLE: Each unit of instruction/module (see IV above) can be subdivided into one or more small, narrowly-defined areas of subject matter. Each of these subdivisions is called a LESSON. Place beside this heading the title of the LESSON being written, numbered according to its position in the unit of instruction/module. Write the lesson title directly below the title of the unit of instruction/module.

e.g. UNIT OF INSTRUCTION 6: USE OF LABORATORY EQUIPMENT
Lesson 2 of 5: Use of the Bunsen burner
e.g. UNIT OF INSTRUCTION 1: FLOW DIAGRAMS OF TREATMENT SCHEMES
Lesson 1 of 1: Drawing Flow Diagrams

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10/1/78

GUIDELINES FOR USING THE PERFORMANCE-ORIENTED INSTRUCTIONAL WORKSHEET, cont'd

VI. ESTIMATED TIME FOR THIS LESSON: Place here the amount of class time the learner will spend (approximately) in working through the lesson (see V above).

e.g. ESTIMATED TIME FOR THIS LESSON: 2 hours

VII. PREREQUISITES FOR THIS LESSON: Place here a description of the skills, abilities, and knowledge that the learner must possess before s/he will be able to profit from the lesson being described. Prerequisities may be stated as a phrase, or as an entire course, unit of instruction/ module, or lesson which should have been taken previously by the learner.

e.g. PREREQUISITES FOR THIS LESSON: Lesson 1 in this unit
e.g. PREREQUISITES FOR THIS LESSON: Unit of instruction 7 in CHEM II
e.g. PREREQUISITES FOR THIS LESSON: Ability to use drafting tools
e.g. PREREQUISITES FOR THIS LESSON: None

VIII. INSTRUCTIONAL OBJECTIVE/PERFORMANCE OBJECTIVE (3 PARTS):

A. ACTION/TERMINAL BEHAVIOR: Place here a clear, unequivocal statement describing what the learner will do/be able to do as a result of the lesson.

e.g. ACTION/TERMINAL BEHAVIOR: The learner will use the Bunsen burner to heat chemicals.

B. CONDITIONS: Place here a statement describing the conditions under which the learner will be expected to demonstrate the ACTION/TERMINAL BEHAVIOR.

e.g. CONDITIONS: Given a Bunsen burner, crucibles, tongs, and samples of chemicals.

C. ACCEPTABLE PERFORMANCE: Place here a statement that describes, quantitatively where relevant, the level of proficiency or accuracy which the learner must demonstrate in performing the action/terminal behavior.

e.g. ACCEPTABLE PERFORMANCE: Lighting and turning off the burner as well as using it to heat chemicals.
e.g. ACCEPTABLE PERFORMANCE: At least 4 factors identified and described.
e.g. ACCEPTABLE PERFORMANCE: 80% accuracy.

GUIDELINES FOR USING THE PERFORMANCE-ORIENTED INSTRUCTIONAL WORKSHEET, cont'd

IX. JUSTIFICATION OF OBJECTIVE: Place beside this heading a brief statement explaining why the learner needs to learn how to perform the specific objective. Write this justification in terms of how the objective ties in with other objectives achieved by the learner, of how the objective will equip the learner for on-the-job performance at a later date, etc.

e.g. JUSTIFICATION OF OBJECTIVE: The learner needs to be able to use lab equipment competently in order to perform standard wastewater laboratory tests.

e.g. JUSTIFICATION OF OBJECTIVE: The learner needs to know the names of professional environmental organizations with which s/he may need to interact in the future.

X. INSTRUCTIONAL RESOURCES:

A. SELECTED: Refer here to specific books, films, self-instructional units, tapes, etc. which are recommended for teaching the lesson being written. References may be coded.

e.g. SELECTED: (IRIS) 122, 179, 208

e.g. SELECTED: Methods and Management. J. A. Hill, editor, McGraw-Hill, New York, New York, 1970.

B. SUGGESTED FOR DEVELOPMENT: Identify here teaching resources which should be developed or written by the instructor (or other person) for use by the learner in enabling the learner to achieve the performance objective.

e.g. SUGGESTED FOR DEVELOPMENT: self-instructional unit on how to draw flow diagrams of treatment schemes.

XI. INSTRUCTIONAL ACTIVITIES:

A. INSTRUCTOR ACTIVITY: Place here a statement or statements of what the instructor may do in order to help the learner achieve the performance objective.

e.g. INSTRUCTOR ACTIVITY: Demonstrates correct use of the Bunsen burner.

e.g. INSTRUCTOR ACTIVITY: Points out examples of degradation of the environment through industrial pollution.

B. LEARNER ACTIVITY: Place here a statement or statements of what the learner should do/what activities the learner should engage in order to achieve successfully the performance objective. Do not include obvious activities such as "reads the instructional resources" or "listens to the instructor's lecture", as these are assumed. The activities suggested should be full enough to give the learner thorough competence in performing the objective.

e.g. LEARNER ACTIVITY: Practices using the Bunsen burner in heating chemicals.
e.g. LEARNER ACTIVITY: Goes on field trip to observe examples of environmental degradation in the locale.

XII. METHOD OF EVALUATION: Write beside this heading a description of how the learner's achievement of the performance objective will be evaluated. It is assumed that the instructor will be the evaluator.

e.g. METHOD OF EVALUATION: Oral or written test.
e.g. METHOD OF EVALUATION: Live demonstration in the lab.

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MODEL SHEET

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COURSE: PROCESS CONTROL
SUBJECT MATTER: LABORATORY

MODULE: THE ACIDITY ANALYSIS

Lesson 6 of 10: Planning the Analysis

ESTIMATED TIME FOR THIS LESSON: 2 hours and 15 minutes

PREREQUISITES FOR THIS LESSON: Lesson 5 in this module

PERFORMANCE OBJECTIVE (3 PARTS): Do Not Film This Page

Action/Terminal Behavior: The learner will describe the principle on which the acidity analysis is based. Then, the learner will write a plan for performing the analysis. The plan will specify the following:

1. the method for the analysis
2. safety precautions to be observed
3. equipment and supplies needed for the analysis
4. factors which can interfere with the analysis and how to minimize them

Conditions: Given Standard Methods for the Examination of Water and Wastewater (latest edition) or other EPA-approved reference

Acceptable Performance: All specifications listed above must be included in the plan for the analysis.

JUSTIFICATION OF OBJECTIVE:

Analyses of acidity are often used for plant process control. Writing this plan helps the learner organize the procedure for doing the analysis.

INSTRUCTIONAL RESOURCES:

Selected 4, 140, 1125, 1127, 1325, 1447, 1594
Clemson University Self-Study Modules for Basic Lab Techniques 1976: "Laboratory Safety"

Suggested for Development: None

Do Not Film This

Instructor activity

1. Help the learner locate the section in a reference which gives instructions for performing the analysis (e.g. section 401 in Standard Methods).
2. Explain that the principle behind the analysis is the neutralization of acid by a standard alkali.
3. Describe the method for the analysis:
   - ° preparation of a standard base
   - ° preparation of an aliquot of the sample
   - ° performing a titration
4. Emphasize safety precautions to be observed during the analysis when:
   - ° preparing reagents
   - ° exposed to contamination
   - ° handling electrical equipment
5. Aid the learner in identifying the supplies and equipment needed for the analysis, including:
   - ° electrometric titrator
   - ° titration vessel
   - ° magnetic stirrer
   - ° pipet
   - ° flasks
   - ° burets
   - ° storage bottles
   - ° reagents
   - ° safety equipment

6. Explain to the learner how to minimize or allow for factors which can interfere with the analysis, such as:
   - ° poorly-prepared reagents
   - ° dissolved gases in reagents
   - ° exposure of sample to atmosphere
   - ° vigorous shaking of sample
   - ° oily matter in sample
   - ° suspended solids in sample
   - ° presence of iron, aluminum, and manganese in sample

Learner activity

1. Locate the section in a reference which gives instructions for performing the analysis.
2. Using these instructions, make notes describing the following:
   - ° the principle behind the analysis
   - ° the method for the analysis
   - ° safety precautions for the analysis
   - ° supplies and equipment needed for the analysis
   - ° methods of preventing interferences with the analysis

METHOD OF EVALUATION: Written test

Instructor activity

1. Help the learner locate the section in a reference which gives instructions for performing the analysis (e.g. section 401 in Standard Methods).
2. Explain that the principle behind the analysis is the neutralization of acid by a standard alkali.
3. Describe the method for the analysis:
   - preparation of a standard base
   - preparation of an aliquot of the sample
   - performing a titration
4. Emphasize safety precautions to be observed during the analysis when:
   - preparing reagents
   - exposed to contamination
   - handling electrical equipment
5. Aid the learner in identifying the supplies and equipment needed for the analysis, including:
   - electrometric titrator
   - titration vessel
   - magnetic stirrer
   - pipet
   - flasks
   - burets
   - storage bottles
   - reagents
   - safety equipment

6. Explain to the learner how to minimize or allow for factors which can interfere with the analysis, such as:
   - ° poorly-prepared reagents
   - ° dissolved gases in reagents
   - ° exposure of sample to atmosphere
   - ° vigorous shaking of sample
   - ° oily matter in sample
   - ° suspended solids in sample
   - ° presence of iron, aluminum, and manganese in sample

Learner activity

1. Locate the section in a reference which gives instructions for performing the analysis.
2. Using these instructions, make notes describing the following:
   - ° the principle behind the analysis
   - ° the method for the analysis
   - ° safety precautions for the analysis
   - ° supplies and equipment needed for the analysis
   - ° methods of preventing interferences with the analysis

METHOD OF EVALUATION: Written test

U.S. GOVERNMENT PRINTING OFFICE 1979-281-147/19